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39 min Au^{190}, 20 min Hg^{190}, and 10 min Hg^{189}

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With 2 figures in the text

ABSTRACT

The decay of conversion electron lines from mass separated sources have been followed in a beta-spectrometer, resulting in the following mass assignments: (38.8 ± 1.8) min Au^{190}, (19.8 ± 0.6) min Hg^{190}, and (9.6 ± 0.4) min Hg^{189}. The half-life of Pt^{189} was measured to be (11.1 ± 0.4) h. Excited levels at 295 and 596 keV in Pt^{190} are indicated from the Au^{190} decay.

Au^{190} has long remained a white spot on the nuclide chart, although isotopes of lower as well as higher mass number have been reported [1]. The recent observation [2] that half-lives of beta-emitters far from stability tend to show systematic variations with mass number made it possible to predict the half-life of Au^{190} to be about 36 minutes (see Fig. 1). As a high-energy reaction has to be used for its production and the neighbouring Au^{189} has been assigned a 42-min period [1], it was evident that mass-separated samples were necessary in the search for the missing isotope. Owing to the lack of a rapid technique for preparing Au samples directly, Au^{190} was looked for as the decay product of Hg^{190}, obtained in the following way.

Gold was bombarded with 110 MeV protons in the Werner synchrocyclotron. After about 30 min irradiation the target was transferred to the ion source oven of our electromagnetic mass separator [3] and heated sufficiently to evaporate the radioactive Hg atoms from the target and into the discharge, which was maintained by stable $PbCl_2$, also supplying reference lines at the collector. Mass number 190 was collected on a thin Al foil (2 mg/cm^2) and placed in the two-directional focusing beta-spectrometer of the Institute [4] within 30 min after the end of the bombardment.

It was suggested by existing data on the first two excited levels of Pt^{196}, Pt^{194}, and Pt^{192} [1], that there would be two $E2$ transitions of about 300 keV in the decay of Au^{190}. Consequently, the proper energy region to detect the K- and L-conversion lines of these transitions was scanned in the beta-spectrometer at about 0.5 % resolution. The lines were indeed found, establishing the transition energies as 295 and 301 keV.

As Hg^{190} had been reported to have a 90-min half-life [5], this was expected to characterize the Au lines in our measurement. In order to obtain the true Au^{190} half-life, it was intended to take out the sample after a couple of runs, remove the Hg by chemical means and then follow the decay of one of the remaining lines in the spectrometer.

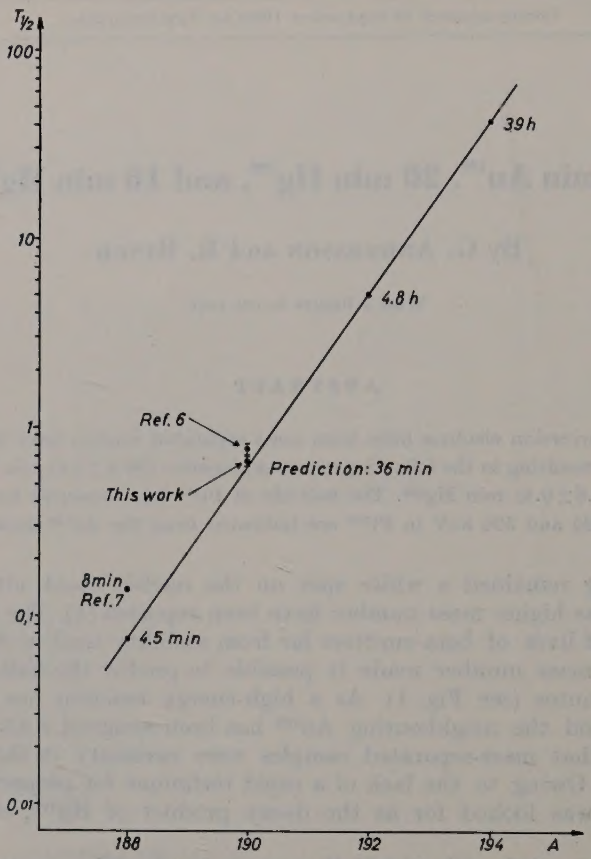

Fig. 1. Half-life systematics of neutron deficient even mass Au isotopes. Results of this work and recent investigations at Orsay are indicated.

However, it turned out that Hg^{190} is in fact much more short-lived, (19.8 ± 0.6) min as measured on a conversion line at 25.5 keV. Thus it became possible to determine the half-life of Au^{190} fairly well without removing the Hg parent. Fig. 2 shows the activity curve of the K-line of the 295 keV transition, which for intensity reasons is interpreted as $(2+)_1 \rightarrow (0+)_{g.s.}$ in Pt^{190}.

The curve resolves into a 20-min parent and a 40-min daughter. In additional runs the same decay was also followed with sources where Hg had been removed[1] about 30 min after the end of the mass separation. From the resulting non-complex decay curves an average value for the Au^{190} half-life of (38.8 ± 1.8) min was obtained. This, on the whole, means a verification of the prediction made from systematics.

The similarity of our Hg^{190} half-life with the reported 20-min period of Hg^{189} [1] made it interesting to reinvestigate the latter decay using the technique described above. Measurement on a conversion line at 153.2 keV gave (9.6 ± 0.4) min, indicating a mistake in the earlier assignment. Rather surprisingly, no lines that could

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[1] We are grateful to Fil. mag. I. B. Häller for the chemical separations.

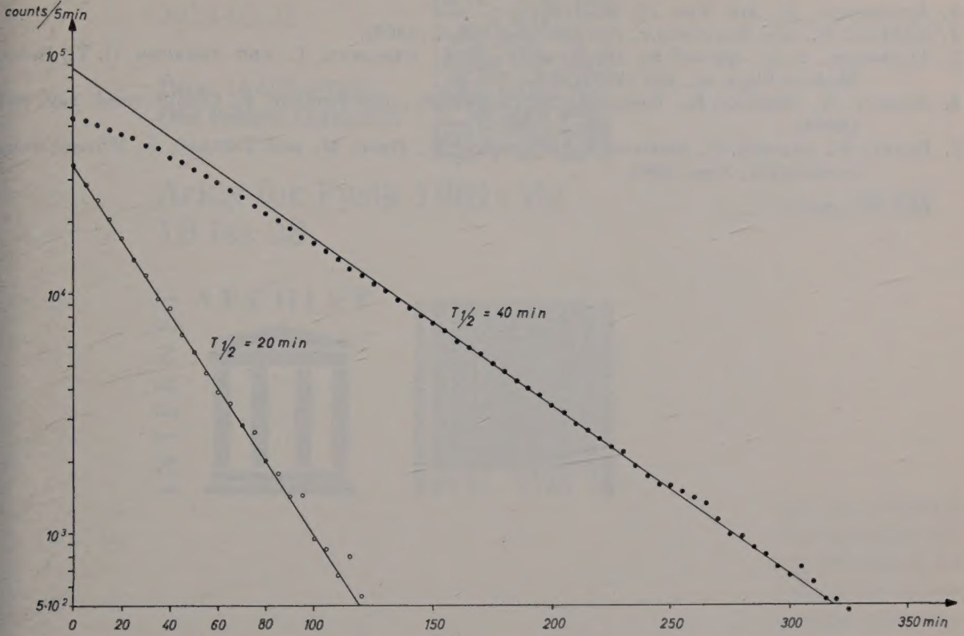

Fig. 2. Activity curve of K 295 in the decay of Au^{190} measured with a Hg^{190} source.

be ascribed to the decay of Au^{189} were observed between 20 and 150 keV. As the search was not very careful and the energy region limited, the negative result does not disprove the existence of a 42-min Au^{189}. Lines due to the Pt^{189} decay were found, however, and an (11.1 ± 0.4) h period was determined by following down an 82.5 keV line.

A weighted least-squares method has been used to calculate the half-lives. The error limits given include the standard deviation and additional 2 % to cover possible systematic errors.

After this paper had been prepared for publication, our attention was drawn to the fact that agreeing results, obtained with essentially the same method of sample preparation but with a scintillation spectrometer as the main measuring instrument, have already been announced by the Orsay group [6, 7]. Their more extensive investigations include even Au^{189} (30 min) and the 188 mass chain. It may be remarked, in view of the above-mentioned half-life systematics, that their assignment of an 8-min period to Au^{188} causes a deviation from linearity in Fig. 1.

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